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Evaluation of the Persistence of Grazing Alfalfa Varieties

Maria Stiles
Western Kentucky University

EVALUATION OF THE PERSISTENCE OF GRAZING ALFALFA VARIETIES

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Maria Raquel Stiles

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Dean, Graduate Studies and Research

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DEDICATION

I dedicate this thesis to all my family and friends who helped instill in me the desire to learn, not only to better myself but also to have a positive impact on my surroundings. To Poppy, Mums, and George, thank you for all the love, support, and encouragement you have given me throughout my life. Thank you also for giving me my love of animals, the environment, and wonderful places.

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Poppy, Mums, and George-thank you for always being so understanding, supporting, and for always loving me in spite of my little imperfections. Thank you for always listening and for being my cheering section.

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The faculty and staff of the Department of Agriculture

"Whoever could make...two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together." -Jonathan Swift (1667-1765)

"A land ethnic...reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity." -Aldo Leopold (1887-1948)

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Directed by: M.R. Stiles, Dr. B.B. Sleugh, Dr. D.A. Stiles, and A.S. Canty

Department of Agriculture Western Kentucky University

The use of alfalfa (*Medicago sativa* L.) for grazing is becoming more common. Alfalfa is the most widely planted legume, and is one of the most nutritional forage crops available. It is proposed that alfalfa was cultivated 4000 to 5000 years ago and produces the most protein per acre of any forage crop. Live weight gains for beef cattle grazing alfalfa average 230 to 360 kg ha^{-1}. There is no cheaper way to harvest and utilize alfalfa than for the animal to harvest it directly.

Most of the commercially available alfalfa varieties, however, were developed for hay production and thus do not always persist under grazing management. Recent advances in alfalfa breeding have provided "dual purpose" cultivars that are now available to producers.

A grazing trial was conducted at the Western Kentucky University Agricultural Research and Education Complex in Bowling Green, Kentucky. Persistence and yield of six commercially available grazing-tolerant alfalfa varieties were evaluated to determine their response to rotational stocking by dairy cows. The varieties, Southern States Graze King, WL 324, Garst 645 II, WL 325 HQ, ABT 405, and Spredor III were established March 29, 2000 and harvested three times for hay throughout the year. Grazing was begun in April 2001 and ended in September 2001. Each plot was grazed when alfalfa

reached a minimum height of 36 cm. Twelve dairy cows (nine Jerseys and three Holsteins) grazed each plot down to approximately 13 cm.

Yield did not differ among varieties ($P \leq 0.05$); however, there was a significant difference among varieties for stand count. The variety by harvest interaction was significant; when averaged across varieties, stand counts declined 48% during the whole season. Southern States Graze King with 8.8 plants 0.1 m^{-2}, was greater only than Spredor III with 6 plants 0.1 m^{-2}.

CHAPTER I

INTRODUCTION

Alfalfa (*Medicago sativa* L.), also called lucerne, was probably the first plant species grown exclusively for forage and was first introduced into the eastern United States by the colonists in 1736. Bolton et al. (1972) proposed that alfalfa was cultivated 4000 to 5000 years ago and that animals probably grazed this alfalfa before people harvested it for hay. Alfalfa is a productive perennial plant that maintains high nutritive quality over a longer time period than any other legume (Hoveland, 1994), and "there is no cheaper way to harvest and utilize alfalfa than for the animal to harvest it directly" (White, 1994). With proper grazing management, the high yield potential of alfalfa can lead to high levels of animal performance per acre. Live weight gains for grazing beef cattle can total 230 to 360 kg ha^{-1}, and average daily gains can be greater than 0.90 kilograms (Lacefield et al., 1997). Alfalfa produces higher protein percentage per hectare than other forage crops (15-22%) as well as ten essential vitamins (Piano et al., 1996).

Alfalfa is the most important forage legume grown in the United States. It is grown in a wide range of soil and climate conditions and has the highest yield potential and feeding value of all perennial forage legumes (Lacefield et al., 1997). Traditionally, alfalfa has been used as a hay and silage crop, but with the introduction of new cultivars with grazing tolerance, many people are beginning to view alfalfa with renewed interest. Alfalfa is an energy efficient crop (in terms of regrowth and water utilization) and an important source of protein, producing yields of up to 2000 kg ha^{-1} protein in temperate climates (Barnes et al., 1988). Including alfalfa in a pasture increases forage yield, crude protein percentage, and digestibility of the forage for the animal. Alfalfa grown in a monoculture had the least yield decline throughout the season (Sleugh et al., 2000). Alfalfa-grass mixtures had the highest overall yield and when averaged over all harvests, alfalfa-grass mixtures had threefold higher yield than smooth bromegrass, orchardgrass, and intermediate wheatgrass grown in monoculture (Sleugh et al., 2000).

Conventional wisdom in North America throughout much of this century was that alfalfa had excellent potential as pasture for high animal performance, but would not survive in many commonly used grazing systems (Smith et al., 2000). Grazing alfalfa has not been practiced to any great extent in the United States, but has been utilized extensively in other countries. Traditionally, in the United States, producers prefer to harvest alfalfa as hay, while in other countries harvesting machinery may not be available and there is no choice other than to graze the forage. The amount of labor and management needed in order to maintain an alfalfa pasture also plays a role in the choice the farmer will make of whether to graze alfalfa. The majority of farmers in the United States view grazing forages as a very time consuming task and would prefer to mechanically harvest the forage.

Fear of livestock losses due to bloat has deterred many producers from grazing pastures containing a significant proportion of alfalfa. Cattle may be prone to bloating because alfalfa has a rapid initial rate of digestion that can be associated with acute changes in rumen microbial populations (Popp et al., 1999). Anti-foaming agents such as

Bloatguard® (poloxalene) are widely used to prevent, control, and treat bloat (Bartley et al., 1967). The difficulties with these anti-foaming agents include costs of the products and ensuring that each animal on pasture receives its proper daily dosage. The surfactant poloxalene (Bloatguard®) has been very effective for the prevention and treatment of bloat, as long as animals consume an adequate amount. Poloxalene has allowed alfalfa to be used more extensively as a grazing forage crop. Bloatguard® can be used effectively to treat cattle with bloat if administered in water either via stomach tube or drench (Bartley et al., 1967). With the introduction of Bloatguard®, bloat has become a less serious threat for the animal and the producer. In field trials where poloxalene was used, producers noticed that milk production increased when cows being fed stored feed were transitioned to a legume pasture (Stiles et al., 1968). Research and producer experience have shown excellent gains per animal and per hectare without a resultant shortening of the alfalfa stand's life expectancy (Popp et al., 1999). Alfalfa varieties have been developed that express tolerance to overgrazing without stand reduction (Spitaleri et al., 2000).

Alfalfa is not without its disadvantages. Of primary concern is the lower persistence of the alfalfa stand under intensive grazing compared to mechanical harvesting. Mechanical harvesting does not cause as much stress on the alfalfa plant due to the fact that machinery is only on the pasture a few times during the season. Animals can cause severe stress to the plant by selectively grazing, treading, and depositing manure and urine onto the pasture, as well as tearing parts of the alfalfa plant when grazing. Without proper management alfalfa stands may not last to their full potential.

Grazing alfalfa also requires a higher level of management and time to maintain productive stands, compared to alfalfa hay or green chop. The cost of machinery for harvest of hay or green chop far exceeds the costs of maintaining an alfalfa grazing system. These are some of the reasons that alfalfa grazing has been done extensively by dairy producers worldwide, but somewhat less by beef producers. Beef cattle producers can benefit from the high quality grazing that alfalfa provides also.

The objective of this research was the evaluate the persistence and yield of six commercially available grazing tolerant alfalfa varieties grazed by lactating dairy cattle, in Bowling Green, Kentucky.

CHAPTER II

LITERATURE REVIEW

Alfalfa Morphology

Alfalfa is a herbaceous perennial legume whose leaves are normally pinnately trifoliolate and arranged alternately on the stem. Mature alfalfa plants may have from 5 to 25 stems and may reach a height of 60-90 cm (Barnes et al., 1995). The crown is first formed at the cotyledon node, at or beneath the soil surface, through contractile growth of the hypocotyl. Secondary and tertiary bud and stem development also occur at this node and other basal nodes. Bud development, along with additional contractile growth and stem thickening, results in a perennial site of meristem activity. Cultivars will vary in crown type and stem number (Barnes et al., 1995). Regrowth following harvest can occur from either crown or axillary stem buds, depending on cutting height and plant type. During the regrowth cycle following harvesting, herbage dry matter yield increases until flowering and subsequently declines due to leaf loss. Yield increases are associated with increases in stem mass and decreases in leaf:stem ratio (Sheaffer et al., 1988). Recommended harvest schedules must consider forage yield, forage quality, stand persistence, and morphological development of the alfalfa plant. As the alfalfa plant matures, apical dominance is broken, and new stems elongate from buds at crowns or stem bases, provided sufficient root carbohydrate levels exist (Fick, 1977).

Alfalfa has a prominent taproot system that may penetrate the soil for 7 to 9 m. This deep taproot system gives alfalfa an advantage in moisture deficient environments.

Alfalfa is very sensitive to soil acidity; therefore, pH values of 6.5-7.0 are required for maximizing forage production (Lanyon and Griffith, 1988). Soil pH influences symbiotic N_2 fixation and the availability of essential elements. Potassium (increases yield, tolerance to severe harvest management, and winter injury), phosphorus (important in seedling development), sulfur, and boron are the most limiting nutrients in alfalfa production, although other nutrients may be deficient in certain soils (Barnes et al., 1995).

Stand Density

In order to establish an efficient forage production system, there must be establishment of a thick, vigorous stand which is essential for optimum yields (Barnes et al., 1995). A thick stand of forage is one that will occupy the majority of the area with little of the soil surface visible. In the initial year that an alfalfa stand is established, an optimum stand of alfalfa would be 30 plants per 0.1 m^{-2}. Populations of alfalfa will decrease by approximately 50% (10 plants per 0.1 m^{-2}) by the second year and by 30% to 50% (5 plants per 0.1 m^{-2}) by the third year before stabilizing. Plant density of a 100% stand of alfalfa would be approximately 50 to 55 stems per 0.1 m^{-2} (Barnes et al., 1995). However, even though there is a dramatic decrease in stand density, this decrease does not necessarily indicate the stand of alfalfa is not productive. Each of the remaining alfalfa plants will compensate by increasing their number of stems. Usually, a stand density of greater than 55 stems per 0.1 m^{-2} will not limit yield. However, in a study of 20 Wisconsin alfalfa fields, Undersander and Cosgrove (1991) observed that a stem density of 18 stems per 0.1 m^{-2} was sufficient to support dry matter yields of 2240-6720 kg ha^{-1}. Lacefield et al. (1997) observed that after 5 years of grazing and haying, AlfaGraze plots still contained 1.9 plants per 0.1 m^{-2} and accounted for approximately 23.5% of total ground cover. Stands of grazing tolerant alfalfa should last as long under proper grazing as others under hay management. It is not known, however, if grazing types will persist longer than hay types when both are managed optimally (Lacefield et al., 1997).

Alfalfa Pasture Forage Quality and Yield

The feeding or nutritive value of alfalfa is well known. Excellent quality alfalfa has a neutral detergent fiber (NDF) concentration between 350 and 450 g kg^{-1} dry matter (Barnes et al., 1995). The small particle size and low proportion of cell walls in the ingested leaves and stems of alfalfa eaten by the grazing animal means that the rumen empties quickly. The animal can then resume eating, resulting in high daily intake (Hoveland, 1994). As with most forages, quality factors such as crude protein decline with increasing plant maturity, while acid detergent fiber and NDF increase in stems compared to leaves (Allen et al., 1986). Generally, alfalfa pasture provides high quality forage that results in excellent performance of lactating dairy cows, growing beef steers, and lambs (Van Keuren and Matches, 1988).

Alfalfa grazing tolerance is useless if the forage dry matter yield is not maintained (Smith et al., 2000). Brisk (1996) reported that unproductive pasture plants with a low growth habit can easily survive grazing by cattle through avoidance. Grazing tolerant alfalfa cultivars are of no use unless animal production is improved. If the available forage is in low quantities or the quality declines (as in the case where the leaves have been eaten, leaving mainly alfalfa stems), then bite size may decline and animals may not have the opportunity to select leafy, high quality forage (Hoveland, 1994). Bouton et al. (1993) found that standard forage dry matter yield testing at three diverse locations indicated that Alfagraze had better forage yield compared with the creeping-rooted cultivar Spredor II and comparable to the mean of all hay-type cultivars entered in the tests. These results indicate that grazing tolerance and yield potential are not mutually exclusive (Smith et al., 2000). Most previously developed grazing tolerant cultivars were developed by selecting for traits associated with grazing tolerance and some of these traits have been associated with low yield (Smith et al., 2000). Joost et al. (1998) observed that forage yield of grazing tolerant alfalfa did not differ among harvest treatments and that significant differences in both yield and persistence were found among cultivars.

Management of Grazing Alfalfa

The Forage and Grazing Terminology Committee (1991) defines a grazing system as "the integrated combination of animal, plant, soil, and other environmental components, as well as, the grazing methods by which the system is managed to achieve specific results or goals." Any grazing system that includes alfalfa must be such that the alfalfa remains productive over its intended or expected life span (Allen, 1992). Even though alfalfa is the highest yielding, highest quality forage legume grown in the United States most available cultivars do not withstand long term, continuous defoliation and should be rotationally grazed to maintain stands (Spitaleri et al., 2000). As further explanation, alfalfa is known to follow a cyclic pattern of root carbohydrate storage and use (Smith, 1960). Continuous stocking, where livestock remain on one pasture for the entire grazing season or at least a major part of the season, is not recommended. Instead, it is recommended that rotational stocking be used, whereby livestock are moved from one pasture to another to allow plants a rest period before being grazed again (Smith et al., 2000). Grazing alfalfa management is similar to hay harvesting management where alfalfa is harvested at pre-bloom to 1/10 bloom for maximum pasture utilization. Alfalfa should be grazed in 5 to 7 days but not exceeding twelve days during periods of active growth (Lodge, 1991). The rest period is approximately the time from the beginning of one grazing cycle until new crown shoots appear and become susceptible to damage from excessive grazing and trampling (Hoveland, 1994). Rest periods that vary in length from 28 to 35 days should also be observed so that the alfalfa stand will have adequate time to replenish its carbohydrate reserves. Alfalfa needs rest periods in order to be productive and have a long stand life. However, these guidelines cannot always be followed exactly. The producer must observe the pasture and take into account environmental conditions and make choices based on those factors that have affected alfalfa growth.

Alfalfa Response to Grazing

Pasture yield, plant stand count, and botanical composition may be affected by multiple factors such as grazing pressure, grazing systems, fertilizers, forage species, and environmental conditions (White and Wight, 1984; Ralphs et al., 1990). Even though alfalfa needs an adequate rest period between harvests, Popp et al. (1997) observed that after the first year of grazing, the proportion of alfalfa increased, while grasses declined within all grazing treatments (continuous and rotational). Popp et al. (1997) also observed that in subsequent years alfalfa declined and grasses increased in all pastures, excluding those stocked heavily and grazed continuously. Smith et al. (1989) concluded that under continuous grazing, cultivars developed for hay production (Apollo and Florida 77) had high mortality rates, which resulted in low spring yields and low forage regrowth. Grazing tolerant cultivars had good persistence under continuous grazing and good midsummer forage regrowth potential, but a long winter dormancy period probably contributed to lower spring yields and lower regrowth potential in the fall (Smith et al., 1989). Persistence of certain cultivars under continuous grazing may be due to maintenance of higher root total nonstructural carbohydrates levels during grazing (Smith et al., 1989).

Grazing tolerance may also be related to the ability of alfalfa plants to maintain leaf area below the grazing height. After defoliation, old leaves low in the canopy regained photosynthetic activity comparable to new leaves (Brummer and Bouton, 1992). Plants with more residual leaf area may be able to regrow utilizing current photosynthate rather than being dependent on root reserves (Gabrielson et al., 1985). Observations by Joost et al. (1998) indicated that grazing tolerant alfalfa plants support regrowth and tolerate grazing by maintaining higher levels of stubble leaf area through producing a greater number of stems and maintaining them below the grazing zone.

Traits for Persistence Under Grazing

Selection for grazing tolerance in alfalfa is related to the ability to identify plant morphological or physiological traits that confer persistence under grazing and enhancing it through selection (Bouton et al., 1997). Other traits associated with grazing tolerance are subsurface budding, extended periods of bud initiation, maintenance of leaf area under grazing, maintenance of root carbohydrates under grazing, disease resistance, and pest resistance (Spitaleri et al., 2000). Although overgrazing is not a recommended management practice for alfalfa, it was used by Bouton et al. (1991) for the breeding and evaluation of nurseries to screen for grazing tolerance. Overgrazing subjects alfalfa genotypes to the stress associated with grazing such as defoliation, tugging and tearing, trampling, defecation, and urination. Another reason for explaining overgrazing is that most livestock producers, regardless of their grazing management system, will overgraze pastures at some point in time (Smith et al., 2000).

Piskovatski and Stepanova (1981) reported that grazing simulation can be useful during early cycle selection for grazing tolerance, but Allen et al. (1986) reported that plant responses to mowing and to grazing are not the same. Counce et al. (1984) stated that mowing did not accurately simulate grazing because it was not well correlated with grazing tolerance among cultivars. There were no differences in persistence of cultivars under mowing, and there was a lack of correlation between mortality under mowing and mortality under grazing. Deep set crowns provided for higher persistence of hybrids to trampling and unfavorable conditions (Piskovatski and Stepanova, 1981). The major factor limiting controlled selection for grazing tolerance in alfalfa is the difficulty in developing accurate techniques to select for the many morphological and environmental traits often associated with grazing tolerance, for example deep set crowns (Piskovatski and Stepanova, 1981).

Most of the currently available grazing tolerant cultivars in North America were selected for broad crowns or for being creeping rooted, which is the ability of new shoots to be initiated from lateral roots (Heinrichs 1963 and 1978). However, the creeping rooted trait has been of limited usefulness in many regions of the United States because of long periods of winter dormancy, slow regrowth rate, and variability of expression (Smith and Bouton, 1993).

Evaluation of Grazing Tolerance

Many North American cultivars marketed today and in the near future, whether as pasture or dual purpose types, will be developed using the approach of survival under intensive grazing with continuous stocking (Smith et al., 2000). The most commonly measured trait in alfalfa cultivar evaluation experiments is dry matter yield. Dry matter yield is measured with plot harvesters that mimic hay and silage operations. It is an important trait for alfalfa hay production, but in the context of grazing systems may not accurately assess the cultivar's pasture performance (Smith et al., 2000).

Alfagraze was the first alfalfa cultivar in North America that claimed to have grazing tolerance. Alfagraze was developed as a dual purpose cultivar, having tolerance to continuous grazing pressure but also producing high forage yields when managed for hay (Bouton et al., 1991). The first series of experiments for Alfagraze were conducted between 1985 and 1991 in Georgia. In these experiments, Alfagraze was tested against two hay type cultivars (Apollo and Florida 77) that had shown good adaptation under hay management in Georgia and two creeping-rooted cultivars (Travois and Spredor II) that had shown good persistence in grazed pastures in the northern Great Plains (Smith et al., 2000). Additionally, when tested against a group of more recently released multiple pest resistant cultivars, Alfagraze demonstrated better plant survival than all other entries (Smith and Bouton, 1993). Results from an on farm demonstration program conducted in 28 states showed that Alfagraze had superior stand persistence when compared to the best adapted varieties over a wide range of environments and grazing systems (Smith and Singh, 2000).

Since variation exists among alfalfa cultivars for persistence under continuous grazing (Counce et al., 1984), selection under continuous grazing may be a better method of identifying persistent plants than selection of morphological traits alone. Two other major factors determining alfalfa stand survival are disease resistance and winter survival. Some researchers have felt that disease resistance would enhance grazing tolerance (Lodge, 1991); therefore, higher levels of disease resistance would lead to improved survival under grazing.

Grazing Management Systems

When establishing a grazing management system, the type of livestock, location and availability of water, and topography must all be taken into account. The weight of the forage available for each individual animal must also be calculated. The type of livestock used is a crucial aspect since cattle defoliate the plant by wrapping their tongue around the plant and tearing it off. However, sheep and horses use their teeth when grazing and can graze the plant down to the soil surface. Obviously, there is no leaf area maintained under severe sheep and horse defoliation, and the resulting stress to an alfalfa plant is dramatic (Smith et al., 2000).

Under management intensive rotational grazing, large areas of pasture are divided into paddocks of varying sizes. The herd is confined to a paddock for a short period and then rotated through the other paddocks on a cycle. Several studies conducted in the southern United States with warm season grass pastures suggest that continuous pasture systems can be as productive as rotational systems when they are managed correctly (Williams and Hammond, 1999). Differences in grazing management and species composition in MIRG (management intensive rotational grazing) and CON (continuous pasture systems) pastures affected the structure of the vegetation in the pasture swards (Paine et al., 1999). Forage mass in MIRG paddocks averaged 800 kg ha^{-1}, more than twice the amount of forage for CON at 390 kg ha^{-1} (Paine et al., 1999).

More intensive management is required for rotational stocking systems; therefore, dairy cattle producers tend to accept intensive grazing more readily than do beef cattle producers. Traditional management of grazed alfalfa has been to approximate hay cutting with grazing imposed at the hay cut growth stage and high stocking rates to graze alfalfa to desired stubble heights within a short period of time (Van Keuren and Matches, 1998). Some forages can produce more dry matter than alfalfa while others can promote greater gains by livestock, but alfalfa is nearly unsurpassed in its high yields of nutrients per acre (Hanson and Barnes, 1978).

Use of Grazing Animals in Alfalfa Pastures

The frustration in the development of grazing tolerant alfalfa is that the improvement of alfalfa for pasture is much more complex than its improvement for hay or protein production because the plant is not the only factor that is being dealt with. The effect of the grazing animal on the pasture is also important (Heinrichs, 1978). Selective grazing, treading, and manure and urine deposition are aspects that cannot be easily simulated- especially when substantial rain occurs and animals are located on alfalfa pasture. Soggy ground makes it especially easy for the animals to severely trample the alfalfa. It is suggested that the producer have a 'sacrifice' field where animals can be placed in order to prevent permanent damage to the alfalfa.

Performance and productivity of cattle are directly related to the quality and quantity of herbage consumed. Acceptability of a feed is assessed by its taste, smell, texture, viscosity, and temperature, with taste being the most important (Goatcher and Church, 1970). Popp et al. (1997) also suggested that cattle grazed fresh alfalfa herbage at a greater rate than those eating freshly cut or wilted alfalfa. However, this rate was true only after the cattle became accustomed to grazing instead of being fed out of a trough.

The only way to reproduce the stress that grazing animals put upon pastures is use the actual grazing animals. Clipping doesn't simulate the extent of crown damage that a tap-rooted plant like alfalfa receives from animal hooves. Efforts to stimulate grazing stress in alfalfa have rarely been successful (Counce et al., 1984). Counce et al. (1984) confirmed the existence of differential persistence of alfalfa cultivars under grazing.

In recent years, there has been increased emphasis placed on growing, harvesting, and incorporating high quality legume forages into dairy rations (Kaiser and Combs, 1989). Three indicators of high quality forage are high potential intake, digestibility, and utilization. Kaiser and Combs (1989) also state that intake is a more accurate measurement of forage quality than is digestibility, although both should be considered. Rotational grazing promotes similar performance, greater forage utilization, and higher milk production among dairy cattle than does continuous grazing.

CHAPTER III

MATERIALS AND METHODS

Introduction

The grazing trial was conducted at the Western Kentucky University Agricultural Research and Education Complex in Bowling Green, Kentucky. Persistence and yield of six commercially available grazing tolerant alfalfa varieties were evaluated to determine how these varieties would respond to rotational stocking by lactating dairy cows.

Plot Establishment

The six alfalfa varieties were each established on 0.19 ha plots on March 29, 2000. The soil is a Pembroke silt loam (Mollic Paleudalf) with a 2-6% slope. Varieties evaluated were Southern States Graze King (Southern States), WL 324 (W-L Research Inc./Green Seed), Garst 645 II (Garst), WL 325 HQ (W-L Research Inc./Green Seed), ABT 405 (ABT/Scott Seed/Spahr Seed), and Spredor III (Novartis). The planting rate was 28 kg ha^{-1} alfalfa drilled into a prepared seedbed. Fertilizer applied on March 28, 2000 consisted of 560 kg ha^{-1} pelletized lime, 22 kg ha^{-1} boron, and 168 kg ha^{-1} diammonium phosphate (DAP). Plots were not grazed in 2000, but were instead harvested for hay three times. No fourth harvest was taken due to an unseasonably late frost.

Experimental Design and Statistical Analysis

The experimental design was a completely randomized design with four replications. Data were analyzed using the PROC GLM procedure of SAS (SAS, 1991). All mean comparisons were done using Least Significant Difference at the $P \leq 0.05$ level of significance.

Grazing Regime

Each plot was grazed when the alfalfa reached a minimum height of 36 cm. Twelve lactating dairy cows (nine Jerseys and three Holsteins) grazed each plot to a height of approximately 13 cm. Each cow was fed 5.5 kg of alfalfa hay, 9 kg of grain, and 20 g of Bloatguard® (53% active ingredient) approximately 45 minutes before being placed on their assigned plot. Cows were placed on their assigned plot at 0800 and removed at 1100 and then returned to their plot, after being milked, at 1700 and removed at 2030. Clean drinking water was supplied to each plot. After grazing, plots were given a rest period of between 18-34 days for regrowth and restoration of root carbohydrate levels. The days of rest between harvests is presented in Table 1.

Sampling of Plots

Plots were sampled when the alfalfa reached a minimum height of 36 cm. Forage availability was monitored at the beginning of each grazing cycle. Samples were harvested using a 0.1 m^{-2} quadrat. Plants within the quadrat were clipped to a height of 5 cm and used to determine dry matter yield. Numbers of alfalfa plants within the quadrat were counted to determine stand density.

Precipitation and Temperature

The daily precipitation and temperature for the months April through September 2001 are presented in Figures 1 and 2, respectively.

Figure 1. April through September precipitation in Bowling Green, KY in 2001.

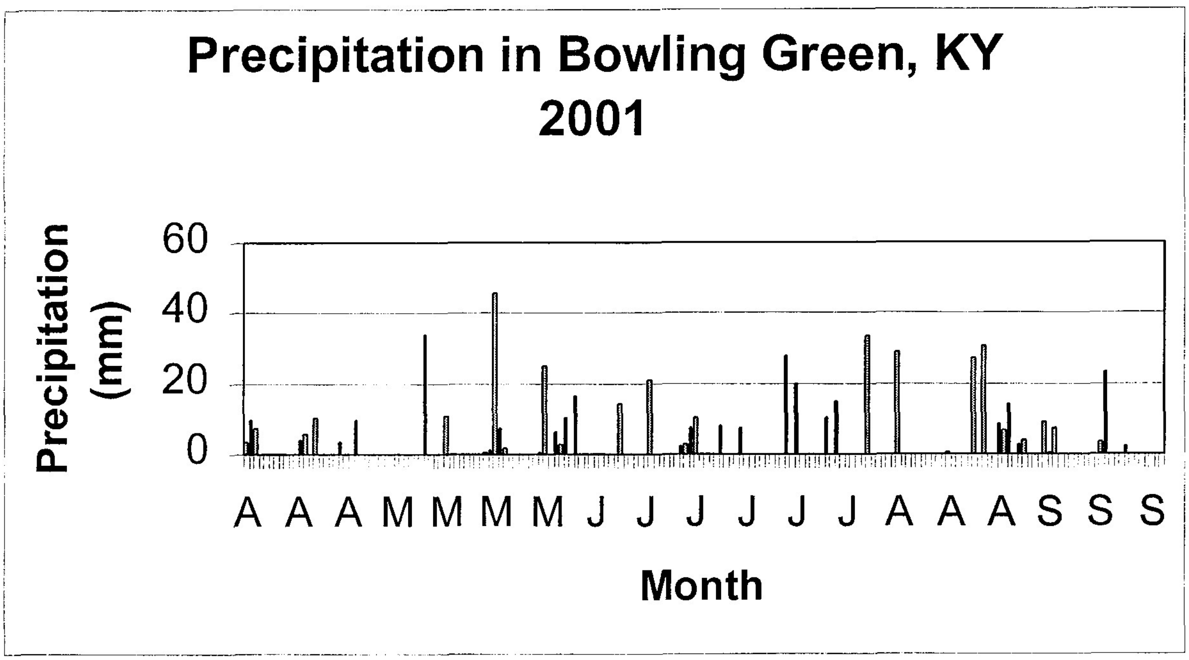

Figure 2. April through September temperature in Bowling Green, KY in 2001.

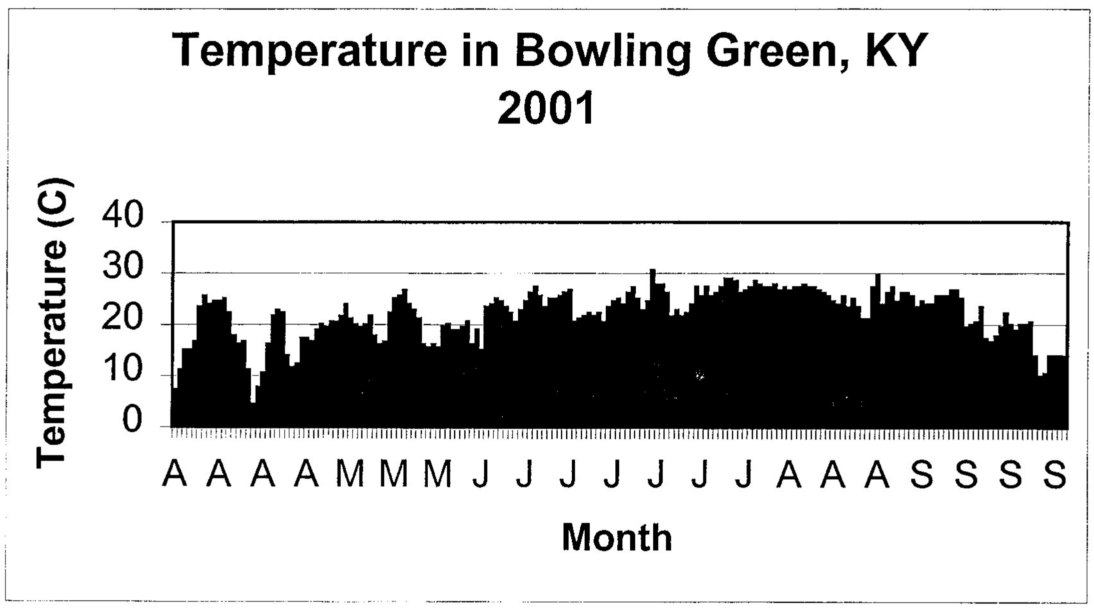

Table 1: Rest period between each harvest for alfalfa varieties in 2001.

VARIETY	HARVEST					
	1	**2**	**3**	**4**	**5**	**6**
	DAYS REST					
S. States Graze King	20	20	17	21	23	79
WL 324	18	21	16	23	29	67
Garst 645 II	20	20	18	25	27	62
WL 325 HQ	23	18	17	25	27	60
ABT 405	34	17	19	23	24	56
Spredor III	27	18	19	28	24	51

CHAPTER IV

RESULTS AND DISCUSSION

Yield

No significant differences in yield occurred among varieties or among harvests ($P \leq 0.05$). Since the summer of 2001 was the first year that this alfalfa stand was grazed, these results might be anticipated. It is for this reason that grazing trials are evaluated for 3 to 4 years so that longer evaluation periods allow for possible differences in yield and persistence to be more accurately delineated. There were no significant differences in dry matter yield of alfalfa varieties averaged over harvests in 2001 (Table 2). On June 1, 2001, 55 dairy cows from the milking herd accidentally grazed the Southern States Graze King variety for approximately 1 to 2 hours. On the night of May 31, 2001, approximately 1 inch of rain fell. We cannot conclude whether the low yield of the Southern States Graze King was due to the trampling of the dairy cows on the saturated ground, the variety, or a combination of both.

There were no significant differences in dry matter yield of harvests in 2001 (Table 3). Our observation is supported by Joost et al. (1998) who found that forage dry matter yield did vary with harvest, but was due to increases in ambient temperature and low levels of available soil moisture in mid-summer. ABT 405 had the second highest yield (4695 kg ha^{-1}) and the second highest stand count (8.1 plants 0.1 m^{-2}). These results are similar, in the trends shown, to those reported by the University of Kentucky's 1999 and 2000 Alfalfa Grazing Tolerance Variety Report (Spitaleri et al., 1999 and 2000).

Stand Count

Stand count differed among varieties ($P \leq 0.05$). Southern States Graze King with 8.8 plants per 0.1 m^{-2} was higher than Spredor III only (Table 5). Even though Southern States Graze King had the highest stand count, it also produced the lowest yield (3747 kg ha^{-1}).

There were also significant differences in stand count among harvest ($P \leq 0.05$). There was a 48% reduction in stand count over the season when averaged over the varieties (Table 6). This may be attributed to dairy cattle defoliating and trampling the plants whenever the plot was grazed, the tolerance of the variety, management practices, and environmental conditions. Similar levels of reduction have been reported by Grimes et al. (1998). Joost et al. (1998) observed that grazing all harvests caused a reduction in crown and stem populations at the end of 2 years of grazing. Even though plant population decreases over the lifespan of the alfalfa, yield is maintained by an increase in the number of stems produced per crown (Beuselinck et al., 1994).

Annotations

It was observed that the cows showed preferences towards specific varieties. This selectivity may have been due to animal preference; thus, if there had been different animals in the grazing trial, their preferences may have been different. Since the alfalfa varieties were not analyzed for nutritional composition, it cannot be concluded that nutrition was a factor in the animals' preferences. Cows tended to graze WL 324 and Garst 645 II more rapidly and with more uniformity than the other varieties. It was also observed that some cows exhibited mild bloat from specific varieties. Southern States Graze King and Spredor III tended to cause more instances of bloat, even though the bloat was not severe. Cows consumed the leafy, upper part of the plant first before consuming the stem and lower part of the plant.

Table 2. Dry matter yield of alfalfa varieties averaged over harvests in 2001.

Variety	Average yield (kg ha^{-1})
Garst 645 II	5394
ABT 405	4695
WL 325 HQ	4544
Spredor III	4497
WL 324	4219
Southern States Graze King	3747

$LSD_{(0.05)}$ = NS

Table 3. Dry matter yield of harvests in 2001.

Harvest	Yield (kg ha^{-1})
1	5326
2	3784
3	3973
4	4408
5	4262
6	5378

$LSD_{(0.05)}$ = NS

Table 4. Total dry matter yield of alfalfa varieties over all harvests in 2001.

Variety	Total yield (kg ha^{-1})	Total yield (t/A)
Garst 645 II	32390	14
ABT 405	28179	13
WL 325 HQ	27261	12
Spredor III	26970	12
WL 324	25334	11
Southern States Graze King	21683	10

Table 5. Stand count of alfalfa varieties after seven grazings in 2001.

Variety	Stand count (plants 0.1 m^{-2})
Southern States Graze King	8.8 a
ABT 405	8.1 a
WL 324	7.8 a
Garst 645 II	7.8 a
WL 325 HQ	7.2 ab
Spredor III	6.0 b

$LSD_{(0.05)} = 1.66$

Table 6. Stand count of alfalfa varieties by harvest in 2001.

Harvest	Stand count (plants 0.1 m^{-2})
1	12.2 a
3	8.1 b
2	7.1 c
5	6.8 c
4	6.7 cd
6	6.5 cd
7	5.8 d

$LSD_{(0.05)} = 0.84$

CHAPTER V

SUMMARY

There is often a relationship between stand count and yield, regardless of the age of the stand and this relationship is also an important factor in stand longevity. Yield increased in the early part of the season, but began to decline after higher mid-season temperatures and lower rainfall. Dry matter yield increased slightly in the later part of the season (harvest 5 though harvest 6). Variation may have been due to a decrease in temperature and an increase in precipitation. Stand counts declined by 48% by the end of the grazing season. Alfalfa stands tend to decrease by 40-60% in the first year. A similar decline has been reported by Grimes et al. (1998).

The data that is presented for this trial represents only one year of grazing. It is expected that subsequent years of grazing may affect the yield and persistence of the varieties more significantly, as well as differences in variety-if any be more profound. Most grazing trials are conducted for 3 grazing seasons or more in order to see differences. In the future, we would anticipate seeing a decrease in yield and stand count, but we anticipate that the alfalfa stand will still be productive. Decreased plant numbers are compensated by greater tiller production by existing plants (Barnes et al., 1995).

When using a rotational stocking system, any alfalfa cultivar can be used for the grazing system. Species, cultivar, and site selection all have a direct influence on forage yield potential. Interaction of species, cultivar, and site, along with harvest management and nutrient management, determine stand life (Barnes et al., 1995). Local adaptation, persistence, winter hardiness, disease and pest resistance and seed quality also play a large role in the quality and productivity of an alfalfa stand. Ways in which the cultivar adapts to the local environment is as important as grazing tolerance to the persistence of the stand. The producer must consider how the stand will be used, where it will be established, and the amount of management that he/she is willing to dedicate to the persistence of the alfalfa stand. All of these factors will contribute to the productivity and success of the alfalfa.

CHAPTER VI

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